

Comments and Response

1. Applicant was duly advised by the Examiner in the above referenced **February 27, 2002**, non-final office action that:
 - a) Claims 15-28 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a non-elected invention;
 - b) the claim for priority under 35 U.S.C. §119 is acknowledged and certified copies of priority documents have been received and are now of record;
 - c) the Examiner has considered the references listed in the Information Disclosure Statement filed May 29, 2001 and returned an initialed copy of the statement;
 - d) Claims 1-2 are rejected under 35 U.S.C. 102(b) as being anticipated by Prior Art as admitted in Applicants' disclosure;
 - e) Claims 3-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Prior Art as disclosed by Applicants (cf. pages 2-3 of the Specification) in view of Huang (U.S. Patent No. 6,110,799); and
 - f) Claims 6-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Prior Art as admitted by Applicants and over Huang (U.S. Patent No. 6,110,799) as applied to claim 3 above, and further in view of Yu, et al. (U.S. Patent No. 5,213,869 B1);
 - g) Claims 11-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Prior Art as admitted by Applicants in their disclosure (pages 2-3 and Fig. 22B) in view of So (U.S. Patent No. 5,895,951);

2. In view of the comments below Applicant respectfully requests that the Examiner reconsider the present application including rejected claims 1-14 and new claims 29 – 63. This amendment and response cancels without prejudice non-elected claims 15 – 28, amends claims 1, 3, 7, 8, and 11 – 14, and adds new claims 29 – 63. No new matter has been added with any of the amendments to claims 1, 3, 7, 8, and 11 – 14 or with any of the new claims 29 – 63. Thus, claims 1 – 14 and 29 – 63 are now pending. In accordance with rule 37 C.F.R. 1.121 and for the Examiner's convenience the Applicant has enclosed herewith a copy of the claims as amended showing any material added or deleted.

- a) Applicant acknowledges the withdrawal of non-elected claims 15 – 28 and herewith has canceled such claims without prejudice.
- b) Applicant notes with appreciation the acknowledgment of the claim to priority under §119 and that the priority documents are now of record.
- c) Applicant further notes with appreciation that the Examiner has considered the material provided by IDS on May 29, 2001 and has returned an initialed copy of form 1449.
- d) Claims 1 and 2 were rejected under 35 USC §102(b) as being anticipated by admitted prior art. The invention of claims 1 and 2 define a semiconductor device and more specifically these claims relate to the impurity concentration profile of the semiconductor device. Claim 1 now recites, among other affirmative limitations, that the impurity concentration profile of the second conductivity type region changes gently in the depth direction of the semiconductor

substrate and has a gentle peak at a depth that is greater than the junction depth of the first conductivity type region. The admitted prior art fails to disclose this feature. This feature helps to solve the problem of variation of the threshold value and breakdown voltage suffered by prior art devices, as mentioned in the Background section of this application. In particular, if there is variation in the threshold value, hole current concentrates at a location where the electron current is large, which creates a hot spot that may result in damage to the element.

Since the recited art does not show or suggest all of the recited limitations Applicant respectfully submits that claims 1 and 2 are not anticipated according to 35 U.S.C. 102(b). Thus Applicant respectfully requests that the Examiner reconsider amended claims 1 and 23 and withdraw the rejection of such claims under 35 U.S.C. 102(b) based on Applicant's discussion of prior art. Applicant respectfully submits that claims 1 and 2 are now in condition for allowance.

e) Claims 3-5 have been rejected under 35 U.S.C. 103(a) as being unpatentable over the Prior Art as disclosed by Applicants (cf. pages 2-3 of the Specification) in view of Huang (U.S. Patent No. 6,110,799). Claim 3 now recites, among other affirmative limitations, a second conductivity type highly doped region having an impurity concentration higher than that of the protrusion region. The depth of the second conductivity type highly doped region is recited to be less than that of the junction of said protrusion region, and the second conductivity type highly doped region is claimed to be located beneath the second trench. Further, claim 3 recites that the protrusion region encompasses the second conductivity type highly doped region. The claimed second conductivity type highly doped region is illustrated as a p⁺ region 74 in Figure 7. Applicant respectfully submits that neither Huang nor the admitted prior art show these features. Huang shows a highly doped p⁺ region 35, however, this region contacts the n layer, which

reduces the withstand or breakdown voltage between the emitter and collector and thus does not effectively solve the problem noted. Therefore, the differences between claims 3-5 and a combination of Huang and the admitted prior art are significant and unobvious.

Since the Huang reference or the admitted prior art taken alone or together does not show or suggest all of the recited limitations of claim 3 and claims 4-5 by dependency, Applicant respectfully submits that claims 3 - 5 are not obvious and thus unpatentable according to 35 U.S.C. 103(a). Therefore Applicant respectfully requests that the Examiner reconsider amended claims 3 - 5 and withdraw the rejection of such claims under 35 U.S.C. 103(a) based on Applicant's discussion of prior art in combination with Huang. Applicant respectfully submits that claims 3 - 5 are now in condition for allowance.

f) Claims 6-10 were rejected under 35 USC §103(a) as being unpatentable over admitted prior art in view of Huang and further in view of Yu *et al.* Claims 6-10 are dependent on claim 3 and are believed to be patentable for the reasons given above. The patent to Yu *et al.* fails to cure the deficiencies of Huang and the admitted prior art, since the Yu *et al.* patent fails to show or suggest the claimed second conductivity type highly doped region.

Since the Huang reference, the admitted prior art, or the Yu *et al.* reference when taken alone or together does not show or suggest all of the recited limitations of claim 6 - 10. Applicant respectfully submits that claims 6 - 10 are not obvious and thus unpatentable according to 35 U.S.C. 103(a). Therefore Applicant respectfully requests that the Examiner reconsider claims 6 - 10 and withdraw the rejection of such claims under 35 U.S.C. 103(a) based on Applicant's discussion of prior art in combination with Huang and further in combination

with Yu *et al.* Applicant respectfully submits that claims 6 - 10 are now in condition for allowance.

g) Claims 11-14 were rejected under 35 USC §103(a) as being unpatentable over admitted prior art in view of So *et al.* Claims 11-14 depend on claim 1 and are believed to be patentable by virtue of such dependency for the reasons given above with respect to claim 1. The So *et al.* patent fails to show or suggest the deficiency of the admitted prior art. That is, the patent to So *et al.* fails to show an impurity concentration profile of a second conductivity type region that changes gently in the depth direction of the semiconductor substrate and has a gentle peak at a location that is deeper than the junction depth of a first conductivity type region. Thus, even if the patent to So *et al.* is combined with the admitted prior art, the limitations of claims 11-14 are not anticipated or suggested.

Since the So *et al.* reference and the admitted prior art, when taken alone or together does not show or suggest all of the recited limitations of claim 11 - 14, Applicant respectfully submits that claims 11 - 14 are not obvious and thus unpatentable according to 35 U.S.C. 103(a). Therefore Applicant respectfully requests that the Examiner reconsider claims 11 - 14 and withdraw the rejection of such claims under 35 U.S.C. 103(a) based on Applicant's discussion of prior art in combination with So *et al.* Applicant respectfully submits that claims 11 - 14 are now in condition for allowance.

h) Regarding new claims 29 - 63

New claims 29 - 33 are dependent claims that are patentable for the reasons given above with respect to their parent claims.

New claim 34 is an independent claim with similarities to claim 3. Claim 34 recites, among other things, a second conductivity type doped region that has an impurity concentration higher than that of the protrusion region. Claim 34 further recites that the second conductivity type doped region has a diffusion depth that is less than the junction depth of the protrusion region, that the second conductivity type doped region is positioned beneath the second trench, and that the protrusion region encompasses the second conductivity type doped region. Neither the admitted prior art nor Huang disclose a second conductivity type doped region that is encompassed by the protrusion region. As mentioned with respect to claim 3, this feature is significant and unobvious. Therefore, claim 34 and its dependent claims 35 - 37 are believed to be patentable over all references of record.

New claim 38 is an independent claim with similarities to dependent claim 6. Claim 38 recites, among other things, a second conductivity type island located on the first semiconductor layer and adjacent to the second semiconductor layer of the trench MOS structure. The second conductivity type island is recited as being isolated from the second semiconductor layer and as being in an electrically floating state. Further, claim 38 recites an upper electrode, which contacts the first conductivity type doped region of the trench MOS structure through the second trench and is isolated from the second conductivity type island. The second conductivity type

island is shown in Figs. 10 and 11 and is described at line 14, page 35 to line 12, page 36. The second conductivity type island is not given a specific reference numeral, but is the part of the second conductivity type layer 43 that is surrounded by the gate electrode 48, as shown in Fig. 11.

The Yu *et al.* reference, in combination with the admitted prior art and the Huang patent was cited to support the rejection of claim 6, which recites subject matter similar to that of claim 38. The Yu *et al.* reference discloses a horizontal type MOSFET, in which the source and drain are laterally separated, unlike the vertical type structure of the present invention. The Yu *et al.* patent shows a floating body 102; however, the floating body 102 is not like the second conductivity type island of claim 38. The floating layer 102 is not located on another layer as claimed, and not isolated from the second semiconductor layer as claimed. Neither the admitted prior art nor the Huang patent shows or suggests the claimed island, and Yu *et al.* cannot cure the deficiency, since the Yu *et al.* patent also fails to disclose or otherwise suggest the claimed island. Therefore, the prior art of record fails to disclose or suggest, alone or in combination, the claimed features, and claim 38 and its dependent claims 39 - 50 are believed to be patentable.

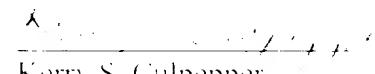
Claim 51 is an independent claim that, like claim 38, recites a floating region. Claim 51 recites, among other things, that the first trench divides the second semiconductor layer into a first portion and a second portion, the second portion being isolated from the first portion. Neither the admitted prior art, the Huang patent nor the Yu *et al.* patent show this arrangement. The second portion is recited to be held in an electrically floating state. The patent to Yu *et al.* fails to show a region that is isolated by a trench and held in an electrically floating state. Therefore, no single reference shows and no combination of the prior art of record could include

the limitations of claim 51. Therefore, claim 51 and its dependent claims 52 - 63 are patentably distinguished from the prior art of record.

Accordingly, Applicant respectfully submits that the claims, as amended, clearly and patentably distinguish over the cited references of record and as such are to be deemed allowable. Such allowance is hereby earnestly and respectfully solicited at an early date. If the Examiner has any suggestions or comments or questions, calls are welcomed at the phone number below.

Please find enclosed a check in the amount of \$1042.00 (\$462.00 for the additional claims, \$400.00 for the two month extension of time as specified in the attached documents and \$180 for submitting a Supplemental Information Disclosure Statement). Please charge any additional fees or credit overpayment to Deposit Account No. **50-1147**.

Respectfully submitted,


Kerry S. Culpepper
Reg. No. 45,672

Law Offices of David G. Posz
2000 L Street, N.W.
Suite 200
Washington, D.C. 20036
Phone (202) 416-1638
Fax (202) 416-1639
Customer No. 23400